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(71) Applicant (for all designated States except US): **EVEN-
TURE GLOBAL TECHNOLOGY [US/US]; 16200 A
Park Row, Houston, TX 77084 (US).**

Wayne [US/US]; 2535 Marsh Lane #1004, Carrollton,
TX 75006 (US). RING, Lev [RU/US]; 14126 Heatherhill
Place, Houston, TX 77077 (US). BRISCO, David, Paul
[US/US]; 405 Westridge Drive, Duncan, OK 73533 (US).

(74) Agents: **MATTINGLY, Todd et al.; Haynes and Boone,
LLP, Suite 4300, 1000 Louisiana Street, Houston, TX
77002-5012 (US).**

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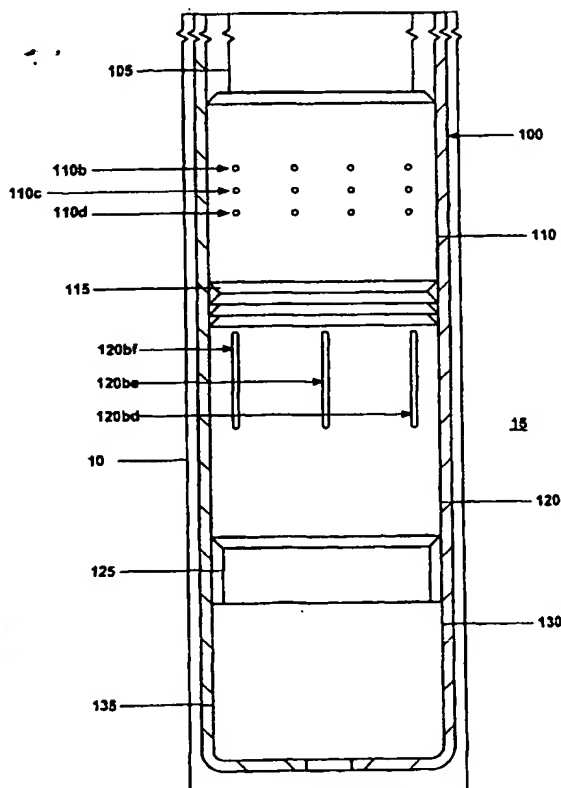
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(72) Inventors; and
(75) Inventors/Applicants (for US only): **WATSON, Brock,**

(54) Title: **APPARATUS FOR RADIALY EXPANDING TUBULAR MEMBERS INCLUDING A SEGMENTED EXPANSION
CONE**

(57) Abstract: **An apparatus for radially expanding tubular
members including a segmented expansion cone.**



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European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : E21B 19/16; 43/00

US CL : 166/380, 207

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 166/380, 207, 209, 212, 216, 217

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 4,420,866 A (MUELLER) 20 December 1983 (20.12.83), figure 1.	1, 6, 8, 11, 13 — 4
X — Y	US 6,085,838 A (VERCAEMER et al.) 11 July 2000 (11.07.00), figures 5-7.	8 — 4

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

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"E" earlier application or patent published on or after the international filing date

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

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Authorized officer

David Bagnell

Telephone No. (703) 308-1113

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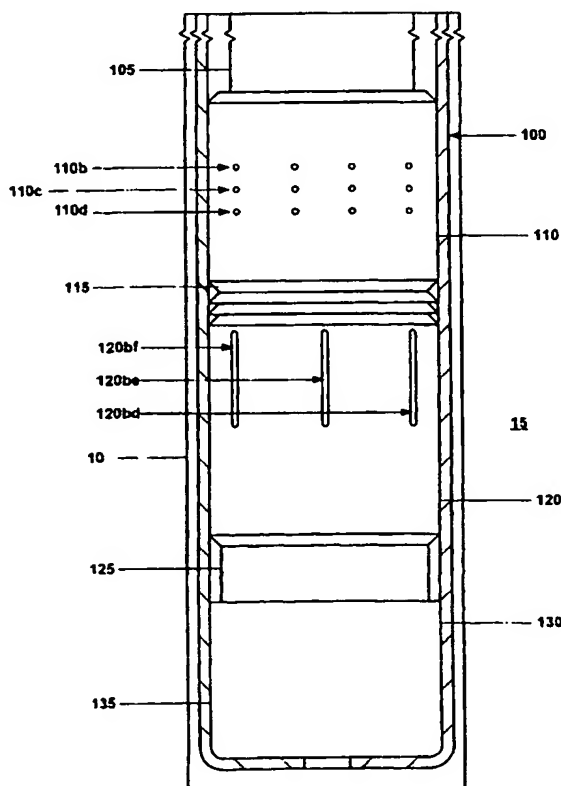
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— with amended claims

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AMENDED CLAIMS

[received by the International Bureau on 19 April 2004 (19.04.2004);
new claims 22-45 added; remaining claims unchanged (6 pages)]

arcuate conical expansion cone segments interleaved among the longitudinal slots;
and

an actuator for adjusting the tubular adjustable expansion cone, comprising:

a first tubular member coupled to the adjustable tubular expansion cone defining a plurality of first radial passage and comprising a plurality of internal flanges interleaved among the first radial passages;

a second tubular member received within the first tubular member defining a plurality of second radial passages interleaved among the first radial passages and comprising a plurality of external flanges interleaved among the first and second radial passages and the internal flanges; and

a tubular expansion cone coupled to the second tubular member for radially expanding the tubular adjustable expansion cone.

20. A method of plastically deforming and radially expanding a tubular member, comprising:
positioning an adjustable tubular expansion cone within the tubular member; and
increasing the size of the adjustable tubular expansion cone within the expandable tubular member, comprising:
positioning a tubular segmented expansion cone within the tubular member;
positioning a tubular expansion cone within the tubular member; and
displacing the tubular expansion cone relative to the tubular segmented expansion cone.
21. An apparatus for plastically deforming and radially expanding a tubular member, comprising:
means for positioning an adjustable tubular expansion cone within the tubular member; and
means for increasing the size of the adjustable tubular expansion cone within the expandable tubular member, comprising:
means for positioning a tubular segmented expansion cone within the tubular member;
means for positioning a tubular expansion cone within the tubular member; and
means for displacing the tubular expansion cone relative to the tubular segmented expansion cone.
22. An apparatus for forming a wellbore casing within a wellbore within a subterranean formation, comprising:
a tubular support member;
an adjustable expansion device coupled to the tubular support member;
an actuator coupled to the tubular support member for adjusting the circumferential size of a segmented outer surface of the adjustable expansion device;
an expandable tubular member coupled to the tubular support member defining a longitudinal passage for receiving the tubular support member, the adjustable expansion device, and the actuator; and
one or more sealing members for sealing the interface between the tubular support member and the expandable tubular member.

23. The apparatus of claim 22, wherein the adjustable expansion device comprises:
a tubular body defining a plurality of longitudinal slots and comprising a plurality of internal arcuate expansion segments interleaved among the longitudinal slots.
24. The apparatus of claim 22, wherein the actuator comprises:
a first tubular member coupled to the tubular support member defining a plurality of first radial passage and comprising a plurality of internal flanges interleaved among the first radial passages;
a second tubular member received within the first tubular member defining a plurality of second radial passages interleaved among the first radial passages and comprising a plurality of external flanges interleaved among the first and second radial passages and the internal flanges; and
an expansion device coupled to the second tubular member for radially expanding the adjustable expansion device.
25. A method of forming a wellbore casing within a wellbore within a subterranean formation, comprising:
positioning an expandable tubular member and an adjustable expansion device within the wellbore;
increasing the circumferential size of a segmented outer surface of the adjustable expansion device within the expandable tubular member; and
plastically deforming and radially expanding the expandable tubular member using the adjustable expansion device.
26. The method of claim 25, wherein increasing the size of the adjustable expansion device within the expandable tubular member comprises:
positioning a segmented expansion device within the expandable tubular member;
positioning an expansion device within the expandable tubular member; and
displacing the expansion device relative to the segmented expansion device.
27. An apparatus for forming a wellbore casing within a wellbore within a subterranean formation, comprising:
means for positioning an expandable tubular member and an adjustable expansion device within the wellbore;
means for increasing circumferential size of a segmented outer surface of the adjustable expansion device within the expandable tubular member; and
means for plastically deforming and radially expanding the expandable tubular member using the adjustable expansion device.
28. The apparatus of claim 27, wherein the means for increasing the size of the adjustable expansion device within the expandable tubular member comprises:
means for positioning a segmented expansion device within the expandable tubular member;
means for positioning an expansion device within the expandable tubular member; and

means for displacing the expansion device relative to the segmented expansion device.

29. An adjustable expansion device for plastically deforming and radially expanding a tubular member, comprising:

an adjustable tubular expansion device; and
an actuator for adjusting the tubular adjustable tubular expansion device.

30. The adjustable expansion device of claim 29, wherein the adjustable tubular expansion device comprises:
a tubular body defining a plurality of longitudinal slots and comprising a plurality of internal arcuate expansion segments interleaved among the longitudinal slots.

31. The adjustable expansion device of claim 29, wherein the actuator comprises:
a first tubular member coupled to the adjustable expansion device defining a plurality of first radial passage and comprising a plurality of internal flanges interleaved among the first radial passages;
a second tubular member received within the first tubular member defining a plurality of second radial passages interleaved among the first radial passages and comprising a plurality of external flanges interleaved among the first and second radial passages and the internal flanges; and
an expansion device to the second tubular member for radially expanding the tubular adjustable expansion device.

32. A method of plastically deforming and radially expanding a tubular member, comprising:
positioning an adjustable expansion device within the tubular member; and
increasing circumferential size of a segmented outer surface of the adjustable expansion device within the expandable tubular member.

33. The method of claim 32, wherein increasing the size of the adjustable expansion device within the tubular member comprises:
positioning a segmented expansion device within the tubular member;
positioning an expansion device within the tubular member; and
displacing the expansion device relative to the segmented expansion device.

34. An apparatus for plastically deforming and radially expanding a tubular member, comprising:
means for positioning an adjustable expansion device within the tubular member; and
means for increasing the circumferential size of a segmented outer surface of the adjustable expansion device within the expandable tubular member.

35. The apparatus of claim 34, wherein the means for increasing the size of the adjustable expansion device within the tubular member comprises:

means for positioning a segmented expansion device within the tubular member;
means for positioning an expansion device within the tubular member; and
means for displacing the expansion device relative to the segmented expansion device.

36. An apparatus for forming a wellbore casing within a wellbore within a subterranean formation, comprising:

- a tubular support member;
- an adjustable expansion device coupled to the tubular support member, comprising:
 - a body defining a plurality of longitudinal slots and comprising a plurality of internal expansion segments interleaved among the longitudinal slots;
 - an actuator coupled to the tubular support member for adjusting the size of the adjustable expansion device, comprising:
 - a first tubular member coupled to the tubular support member defining a plurality of first radial passage and comprising a plurality of internal flanges interleaved among the first radial passages;
 - a second tubular member received within the first tubular member defining a plurality of second radial passages interleaved among the first radial passages and comprising a plurality of external flanges interleaved among the first and second radial passages and the internal flanges; and
 - an expansion device coupled to the second tubular member for radially expanding the adjustable expansion device;
 - a shoe releasably coupled to the adjustable expansion device;
 - an expandable tubular member coupled to the shoe defining a longitudinal passage for receiving the tubular support member, the adjustable expansion device, and the actuator; and
 - one or more sealing members for sealing the interface between the tubular support member and the expandable tubular member.

37. A method of forming a wellbore casing within a wellbore within a subterranean formation, comprising:

- positioning an expandable tubular member and an adjustable expansion device within the wellbore;
- increasing the size of the adjustable expansion device within the expandable tubular member, comprising:
 - positioning a segmented expansion device within the expandable tubular member;
 - positioning an expansion device within the expandable tubular member; and
 - displacing the expansion device relative to the segmented expansion device; and
 - plastically deforming and radially expanding the expandable tubular member using the adjustable expansion device.

38. An apparatus for forming a wellbore casing within a wellbore within a subterranean formation, comprising:

- means for positioning an expandable tubular member and an adjustable expansion device within the wellbore;

means for increasing the size of the adjustable expansion device within the expandable tubular member, comprising:

means for positioning a segmented expansion device within the expandable tubular member;
means for positioning an expansion device within the expandable tubular member; and
means for displacing the expansion device relative to the segmented expansion device; and
means for plastically deforming and radially expanding the expandable tubular member using the adjustable expansion device.

39. An adjustable expansion device for plastically deforming and radially expanding a tubular member, comprising:

an adjustable tubular expansion device, comprising:

a tubular body defining a plurality of longitudinal slots and comprising a plurality of internal expansion segments interleaved among the longitudinal slots; and

an actuator for adjusting the adjustable tubular expansion device, comprising:

a first tubular member coupled to the adjustable tubular expansion device defining a plurality of first radial passage and comprising a plurality of internal flanges interleaved among the first radial passages;

a second tubular member received within the first tubular member defining a plurality of second radial passages interleaved among the first radial passages and comprising a plurality of external flanges interleaved among the first and second radial passages and the internal flanges; and

an expansion device coupled to the second tubular member for radially expanding the adjustable tubular expansion device.

40. A method of plastically deforming and radially expanding a tubular member, comprising:

positioning an adjustable tubular expansion device within the tubular member; and
increasing the size of the adjustable tubular expansion device within the expandable tubular member, comprising:

positioning a tubular segmented expansion device within the tubular member;
positioning an expansion device within the tubular member; and
displacing the expansion device relative to the segmented expansion device.

41. An apparatus for plastically deforming and radially expanding a tubular member, comprising:

means for positioning an adjustable expansion device within the tubular member; and
means for increasing the size of the adjustable expansion device within the expandable tubular member, comprising:

means for positioning a segmented expansion device within the tubular member;
means for positioning an expansion device within the tubular member; and
means for displacing the expansion device relative to the segmented expansion device.

42. A method of radially expanding and plastically deforming a tubular member, comprising:
positioning an adjustable expansion device within the tubular member;
adjusting a size of the adjustable expansion device within the tubular member; and
displacing the adjustable expansion device relative to the tubular member by pulling the
adjustable expansion device through the tubular member using fluid pressure.
43. A system for radially expanding and plastically deforming a tubular member, comprising:
means for positioning an adjustable expansion device within the tubular member;
means for adjusting a size of the adjustable expansion device within the tubular member; and
means for displacing the adjustable expansion device relative to the tubular member by
pulling the adjustable expansion device through the tubular member using fluid pressure.
44. A method of radially expanding and plastically deforming a tubular member, comprising:
positioning an expansion device within the tubular member; and
displacing the expansion device relative to the tubular member by pulling the expansion
device through the tubular member using fluid pressure.
45. A system for radially expanding and plastically deforming a tubular member, comprising:
means for positioning an expansion device within the tubular member; and
means for displacing the expansion device relative to the tubular member by pulling the
expansion device through the tubular member using fluid pressure.